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COMPLETE SPECIFICATION

Insert for use in a Drilling String

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This invention has to do with an insert for use in a drilling string, that is, in a string or assembly of equipment used in the drilling 15 of a well such as an oil well, and it is a general object of the invention to provide a simple, practical, effective and safe device useful, generally, in a drilling string at or near the lower end thereof, as for instance, 20 adjacent or in combination with the bit or adjacent or in combination with a drill collar that may be located above the bit.

A general object of this invention is to provide a device or insert applicable to a 25 drilling string to occur between parts that are normally joined together, as for instance, between a bit and the lower end of a drill collar or between the upper end of a drill collar and the lower end of a string of drill pipe, 30 the device being such as to project outward to bear upon or engage the wall of the well bore and serve as a fulcrum or guide.

A general object of the invention is to provide an insert for a drilling string of the 35 general character referred to in which the parts subject to wear or deterioration are readily replaceable or renewable, the construction being such that the necessary repairs for proper maintenance of the device 40 may be made in the field, as for instance, in the derrick located at the well where the structure is used.

Another object of this invention is to provide an insert for a drilling string of the 45 general character referred to which projects

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in a manner to engage the wall of the well bore to provide a point of bearing in the bore and which is so formed and constructed that the projecting parts may be easily and quickly reduced or even possible completely 50 eliminated in the event that it becomes necessary to relieve the drilling string of the obstructions created thereby. This feature is particularly important when the structure is used in the drilling string at a point well 55 above the bit. With the structure provided by the invention should the drilling string become stuck it may be easily and quickly released or freed as by a washover operation in the course of which the projecting 60 portion of the insert may be cut away. This washover operation consists in reciprocating and rotating a washover tool on a drilling string to flush and abrade away material lodged around the exterior surface thereof. 65 The washover tool can also be associated with a cutting tool to remove or cut away obstructing material jammed between the drilling string and the wall of the well bore.

Another object of the invention is to provide 70 an insert of the general character referred to applicable to a drilling string having a fluid circulation opening therethrough, which insert has a central flow conducting passage corresponding in size and shape with 75 the passage in adjoining parts of the string so that the insert does not restrict or impair flow through the string or the passage of instruments or equipment through the string when such operations are necessary or 80 desired.

A further object of this invention is to provide an insert applicable to a drilling string which is of simple, sturdy, dependable construction, and which can be used to perform 85 various functions or when various operations are desired. The insert can be so utilised as to act, generally, as a stabiliser for the drill pipe, or it can be used as a centralising device for the drill pipe, or it may be 90

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used as a fulcrum on the drill pipe to have bearing on the wall of the well bore, or it may be used in situations where it, in effect, combines such functions or actions. The structure may in practice be used to advantage in operations such as hole straightening or deflection, side tracking or whipstocking, or the like.

A further object of the invention is to provide a structure of the general character referred to in which the projecting means of the insert are ribs or drillable material, the ribs being protected by caps of steel or the like which in turn may be hard-faced, the caps being formed with or to the ribs as by casting or forging so they are securely and dependably held.

The present invention provides an insert for a drilling string characterised by an elongate tubular body, the outside of which is round in cross-section, or turned. The outside diameter of body is at least equal to the outside diameter of the drilling string to which the insert is connected. The inside or bore of the body corresponds in size and shape with the circulation openings in the adjoining parts of the string and it is clear or unobstructed, so that it offers no obstruction to fluid or elements required to be passed therethrough.

The invention provides a plurality of elongate ribs on the exterior of the body, which ribs are preferably straight, equally spaced around the body, and pitched relative to the longitudinal axis of the body so that they combine to provide an effective guide centering the body in the well bore. The ribs are of limited extent circumferentially or in width, with the result that the structure provides large or wide spaces between the ribs to adequately handle circulation of fluid past the structure.

The invention provides a detachable mounting for each rib so that it can be removed from the body for replacement or repair when necessary. The ribs are preferably formed of drillable material such as an aluminium alloy or the like, while the body is preferably formed of steel of a quality corresponding in strength and durability to that out of which the other elements of the drill string are formed. A shoe is anchored on the outermost part or face of each rib and preferably extends over at least one end of the rib. The shoe is a wear-taking part preferably having an outer face surfaced with hard wear-taking material and is cylindrically curved. The shoes or wear-taking parts when employed on the outer portions of the ribs are preferably cast with the ribs to be in effect integral therewith.

The various objects and features of our invention will be fully understood from the following detailed description of a typical preferred form and application of the inven-

tion, throughout which description reference is made to the accompanying drawings, in which:—

Fig. 1 is a view illustrating the insert provided by the present invention in a well drilling string near the lower end thereof, a unit embodying the invention being illustrated between the upper end of the drill collar and the lower end of the string of drill pipe;

Fig. 2 is a view showing the insert provided by the present invention located between the lower end of the drill collar and the bit and being used as a fulcrum to cause the bit to be deflected from a central position in the bore;

Fig. 3 is an enlarged side elevation of the insert showing the details of construction employed therein;

Fig. 4 is a view taken as indicated by line 4—4 on Fig. 3;

Fig. 5 is an enlarged detailed sectional view taken as indicated by line 5—5 on Fig. 3; and

Fig. 6 is an enlarged sectional view taken as indicated by line 6—6 on Fig. 3.

The device provided by this invention is intended for use in a well drilling string and in a usual application of the invention it is installed or incorporated in the drilling string near the lower end thereof. In the drawings in Fig. 1 one insert of the present invention is applied between the upper end of the drill collar A and the joint element on the lower end of a string B of drill pipe. It is to be understood that we may use more than one insert in a single string and that the inserts when used may be located as circumstances require. In this particular case a reamer C is illustrated at the lower end of the drill collar to occur between the drill collar and a typical bit D. In the form of the invention illustrated in Fig. 2 the insert provided by the present invention is applied between the lower end of the drill collar A and the bit D so that the insert acts a fulcrum allowing the drill pipe above the insert to lean to one side, say to the left as shown in Fig. 2, and thus cause the bit to lead off or bear in the opposite direction. These typical applications or installations of the insert are set forth to facilitate an understanding of how it can be used in practice, and are given as typical examples of use.

The insert provided by the present invention involves, generally, a body E with coupling means F at its ends, a plurality of ribs G carried by the body and projecting from the exterior thereof, the ribs being releasably secured to the body by mounting means H, wear-taking shoes J on the ribs, means K securing the shoes on the ribs, and various other features of construction and arrangement of parts as will be hereinafter described.

The body E in accordance with the pre-

sent invention is a simple elongate tubular element, preferably formed of steel, or like material, such as is used in the other parts of the drilling string. In the preferred form of the invention the outside 10 of the body E is round or turned concentric with the longitudinal axis of the structure, while the opening 11 through the body is in the nature of a fluid passage or bore corresponding in size and shape with the fluid passages 12 in the other parts of the drilling string. The bore 11 is shown as corresponding in size and shape with the fluid passages 12 in the adjoining parts of the drilling string and it will be apparent from the drawings that the bore 11 is clear and unobstructed so that it does not retard flow of circulating fluid and permits ready passage of tools or instruments as circumstances may require.

The coupling means F occur at the ends of the body E and are provided for releasably coupling the insert with the other parts of the string. In the case illustrated the coupling means F at the lower end of body E is in the form of a threaded pin 15 while at the upper end of the body it is formed by a threaded socket 16.

In accordance with the present invention a plurality of ribs G are provided to occur on the exterior of body E so that they project radially outward therefrom, and although the ribs may vary in number, form and design, it is preferred that there be but three ribs spaced 120° apart around the body and that they be pitched so that they are angularly disposed relative to the longitudinal axis of the body, preferably at about 30° thereto. It is preferred that the several ribs be straight elongate elements of considerable length and also of substantial width. The ribs are spaced a substantial distance apart so that there are substantial openings or channels at 20 between adjacent ribs providing adequate means for handling fluid that must circulate past the ribs.

In accordance with the present invention each rib is an elongate body or block of drillable material and is generally rectangular in cross-sectional configuration so that it has flat parallel sides 21 and a top 22. In practice the ribs may be formed of various materials subject to being drilled or disintegrated. In accordance with the invention the ribs are formed of a material such as an aluminium alloy that can be readily drilled up or destroyed by cutting tools ordinarily employed in well drilling. When the term "drillable material" is used we mean to refer to or to include material or materials of such character as to be subject to removal by means of the general character operable in well bores.

The mounting means H for each rib G secures the rib to the body E so that it projects from the exterior of the body and is

disposed at the desired angle. In the preferred form of the invention the mounting means H is such as to releasably hold the rib so that it may be detached from the body and is rigid on the body during operation of the structure. In the preferred form of the invention the mounting means H involves a tongue and groove construction and as shown in the drawings a groove 30 is cut in the exterior of the body E at the desired angle and to the desired depth, while the inner portion 31 of the rib G is in the nature of a tongue which seats in and occupies the groove. In the case illustrated the bottom portion of the groove 30 is enlarged or undercut at 32 and the tongue portion 31 is flared or enlarged to fit into the undercuts. The bottom 38 of groove 30 is preferably flat and the rib has a flat bottom that seats or bears on the bottom 38. The manner in which the tongue engages and fits the groove is clearly illustrated in Fig. 5 of the drawings.

In the preferred form of the invention the groove 30 in the body is slightly tapered or convergent so that it is narrower at its upper end than at its lower end and the tongue portion 31 is correspondingly shaped or tapered so that it has a wedging engagement in the groove. In the particular case illustrated the entire rib is tapered to correspond with the tongue.

One or more stops are provided to positively retain the rib in engagement with the body and in the form of the invention illustrated a stop 39 engages one end of the rib and a stop 40 engages the other end of the rib. The stops 39 and 40 may be in the nature of blocks engaged in sockets or recesses 41 in the bottom 38 of the groove 30 where they are suitably retained to project up from the bottom and thus confine the rib in the groove. Stop 39 engaged by the upper end of the rib is preferably fixed in place as by welding whereas the stop 40 is releasable or removable. Stop 40 is shown held in place by a screw fastener 42. The stop blocks are preferably elongate in form and are disposed so that they extend transversely of the groove 30 as shown in Fig. 3 of the drawings. It will be apparent that the block 39 at the upper ends of the rib may be eliminated if desired since the tapered construction prevents passage of the rib upward beyond the position shown in the drawings.

In the form of the invention illustrated there is a single wear-taking member or shoe J on the outer face 22 of each rib G and this shoe covers the face 22 and has an end extension that covers an end of the rib. Shoe J is preferably formed of wear resisting material such as steel and its outer face is preferably surfaced with hard-facing material 46, or the like. The outer surface 46 of the shoe, occupied by the hard-facing, is curved so that it is concentric with the central

longitudinal axis of the tool. In practice the hard-facing 46 may be tungsten carbide or other suitable material secured or applied to the shoe J in any suitable manner. The extension 47 of the shoe is integral with the portion of the shoe that covers the outer face of the rib and occupies all or part of one end of the rib. In the preferred construction both ends of the rib are bevelled off or inclined and the extension is likewise inclined and covers or protects a substantial portion of the lowermost end of the rib. The bevelled ends of the rib prevent the insert from catching as it is moved lengthwise in either direction and the shoe part protecting the lower end of the rib prevents wear of the rib at that end under normal operating conditions.

In practice we prefer to form the shoes for each rib as a casting and the means K joins each shoe to its rib so that these parts are firmly and rigidly connected. We contemplate that in some cases the shoes may be shaped or worked as by bending or forging so that they are properly secured to or on the ribs. In the preferred construction a pair of longitudinal parallel ridges 50 project from the outer face 22. The ridges are spaced apart and have inner sides or edges 51 that are opposed and which defines an undercut or dove-tailed channel which is occupied by a projection 52 on the inner side of the shoe J. The outer sides 53 of the ridges are inclined or outwardly convergent and the shoes have side portions 54 that overlie the outer sides of the ridges.

In manufacture we cast the drillable material to the previously cast shoes and as a result the material of each rib shrinks on to the projection 52 of the shoe of that rib so that the joinder between the shoe and rib is solid and permanent. If desired the structure of means K can be continued along the extension of each shoe and there may be cases in which we provide extension of the shoes at both ends thereof.

From the foregoing description it will be observed that the construction provided by the present invention is simple, inexpensive and sturdy. The ribs being detachable or separable from the body can be renewed or replaced when necessary and the ribs and their shoes, being formed by casting, are inexpensive of manufacture. Renewal or replacement of the ribs can be easily performed at the derrick or the point where the structure is used.

It will be apparent that the insert can be used in a drilling string at various points, for instance, in a manner such as is shown in Fig. 1, or as shown in Fig. 2, and when in use the cylindrically curved outer faces 46 of the shoes afford effective and substantial bearing engagement with the wall of the bore where the bore corresponds in diameter

with the insert. It will be apparent that the insert may be used or may act as a stabiliser, centraliser or fulcrum. In the event that the drill pipe should twist off or become stuck and material should lodge around the insert so that the projecting ribs thereof interfere with removal of parts of the string, a wash-over tool can be operated over the insert and a cutting tool can be readily operated in such manner as to remove or cut away the ribs. In the case of such an operation the steel shoes J may not be cut or broken up but they become disengaged, and being relatively small, are not serious obstructions.

Having described only a typical preferred form and application of our invention, we do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to ourselves any variations or modifications that may appear to those skilled in the art and fall within the scope of the following claims:—

What we claim is:—

1. An insert for use in a drilling string, including an elongate tubular steel body at least of the same outside diameter as the drilling string, means detachably mounting a plurality of ribs on the exterior of the body, and shoes of wear resisting material on the outermost faces of the ribs adapted to resist wear as the insert is operated with the drilling string.

2. An insert as set forth in Claim 1, in which the ribs are in spaced relation around the body and project radially outwardly of the body to extend longitudinally thereof and at an angle to the longitudinal axis of said body.

3. An insert as set forth in Claim 2, in which the ribs are made of a drillable material, whereby said radially projecting ribs facilitate operation of a washover and cutting tool to cut said drillable ribs between the body and said shoes.

4. An insert as set forth in Claim 1, 2, or 3, in which the drilling string includes pipe sections and separable elements larger in diameter than the pipe sections, said body being adapted to be arranged between said elements and connected thereto by coupling means at its ends, and said body being at least of the same outside diameter as said elements.

5. An insert as set forth in Claim 4, in which the pipe sections and separable elements of the drilling string have a central longitudinal flow conducting opening there-through, and said body has a flow passage therethrough corresponding in size with said opening through said string.

6. An insert as set forth in any of Claims 1 to 5, in which the detachable mounting for said ribs includes a tongue on each rib extending longitudinally thereof and held in a groove in the exterior of the body extending

at an angle to the longitudinal axis of said body.

7. An insert as set forth in Claim 6, in which the groove is transversely undercut and longitudinally tapered so that it is upwardly convergent and the tongue being of the same shape as said groove to wedge tightly therein, and the ends of each rib being bevelled so that they converge as they extend radially outward from the body.

8. An insert as set forth in Claim 6 or 7, including a stop in the groove at each end of the tongue to hold said tongue against movement longitudinally in said groove.

9. An insert as set forth in any of Claims 1 to 8, in which the shoes have curved faces concentric with the central longitudinal axis of said body and have lower end portions

extending inwardly toward the body at the end of the ribs.

10. An insert as set forth in any of Claims 1 to 9, in which said shoes are mounted substantially co-extensive with the outermost faces of said ribs by projections on said shoes embraced by converging opposed sides of ridges formed on said ribs, said ridges being confined between sides of the shoes.

11. An insert for use in a drilling string substantially as described and shown in the accompanying drawings, and for the purpose set forth.

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